

REGOLITH WATER VAPOR SOURCES ON MARS: A HISTORICAL  
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The existence of regolith water vapor sources on Mars was first considered by several investigators during the early 1970s. They speculated on the possible existence of a down slope source for the vapor that condensed to form the prominent Tharsis 'W' cloud. These discussions appeared in the following papers:

Leovy et al., Mariner Mars 1969: Atmospheric results, J. Geophys. Res. 76, 297-312, 1971.

Leovy et al., Mars atmosphere during the Mariner 9 extended mission: Television results, J. Geophys. Res. 78, 4252-4266, 1973.

Peale, S. J., Water and the Martian W cloud, Icarus 18, 497-501, 1973.

Fanale, F. P. and W. A. Cannon, Exchange of adsorbed  $H_2O$  and  $CO_2$  between the regolith and atmosphere of Mars caused by changes in surface insolation, J. Geophys. Res. 79, 3397-3402, 1974.

During the 1973 Mars opposition, a major dust storm was observed in the Solis Lacus ( $-25^{\circ}S, 85^{\circ}W$ ) region. Earth-based vidicon images revealed that the initial dust cloud was bright at both blue and red wavelengths. McCord et al. (1977) interpreted this observation as an indication that the cloud contained a significant amount of condensate. Blue filter brightenings were also observed in an apparent ring around the central plume. The radius of the ring was estimated to be 600-1000 km. The relationship of these features led McCord et al. (1977) and Huguenin et al. (1978; 1979) to conclude that the ring was the result of vapor transport from the central plume. Based on this assumption, they argued that a major source of atmospheric water vapor existed in Solis Lacus. The case for a regolith source is detailed in the following publications:

McCord et al., Photometric imaging of Mars during the 1973 opposition, Icarus 31, 293-314, 1977.

Huguenin et al., Mars: Remote spectral identification of  $H_2O$  frost and mineral hydrate, Proc. 2nd Colloq. Planetary Water and Polar Processes, 100-108, 1978.

Huguenin, R.L., Mars: possible occurrence of near-surface liquid  $H_2O$  brines in the Solis Lacus region ( $-25^{\circ}S, 85^{\circ}W$ ), LPSC X, 596-597, 1979.

Huguenin et al., Mars: An oasis in Solis Lacus ( $-25^{\circ}\text{S}$ ,  $85^{\circ}\text{W}$ )?  
Eos: Trans. AGU 60, 306, 1979.

Huguenin et al., Remote sensing evidence for oases on Mars, NASA TM-80339, 208-214, 1979.

Huguenin, R.L. and S.M. Clifford, Additional remote sensing evidence for oases on Mars, NASA TM-81776, 153-155, 1980.

Huguenin, R.L. and S.M. Clifford, Remote sensing evidence for regolith water vapor sources on Mars, J. Geophys. Res. 87, 10227-10251, 1982.

Huguenin et al., Freeze/thaw injection of dust into the Martian atmosphere, LPSC XVI, 376-377, 1985.

Huguenin et al., Injection of dust into the Martian atmosphere: Evidence from the Viking gas exchange experiment, Icarus 68, 99-119, 1986.

The suggestion that Solis Lacus was a significant source of atmospheric vapor was vigorously contested by a number of investigators associated with the Viking mission, most notably the team members of the Mars Atmospheric Water Detector (MAWD) experiment. They argued that the water vapor column abundances measured over Solis Lacus did not differ appreciable from those measured over any other location at the same latitude. Their arguments are best summarized in the following two papers:

Jakosky, B.M. and C.B. Farmer, The seasonal and global behavior of water vapor in the Mars atmosphere: Complete global results of the Viking Atmospheric Water Detector experiment, J. Geophys. Res. 87, 2999-3019, 1982.

Jakosky, B.M., The seasonal cycle of water on Mars, Space Sci. Rev. 41, 131-200, 1985.

The proposal that a near-surface reservoir of  $\text{H}_2\text{O}$  might exist in Solis Lacus led Zisk and Mouginis-Mark (1980) to analyze radar data from this region for any anomalous behavior indicative of a seasonal freeze-thaw cycle in the upper few centimeters of regolith. Surprisingly, their preliminary analysis revealed evidence that indicated this kind of activity. Considerable controversy ensued regarding the validity of this interpretation. This led Zisk and Mouginis-Mark (1981) and Roth et al. (1984; 1985) to reconsider the radar data. The results of this reanalysis are not conclusive, but tend to favor the original interpretation. However, because a number of questions remain, analysis of the radar data is still ongoing. Readers are therefore advised to consult the current literature for reports

of the most recent results. The following publications provide an overview of the initial stages of the radar debate:

- Zisk, S.H. and P.J. Mouginis-Mark, Confirmation of anomalous areas ("oases") on Mars from Earth-based radar data, LPSC XI, 1297-1299, 1980.
- Zisk, S.H. and P.J. Mouginis-mark, Anomalous region on Mars: Implications for near-surface liquid water, Nature 288, 126-129, 1980.
- Mouginis-Mark et al., Characterization of Martian surface materials from Earth-based radar: The Memnonia Fossae region, Proc. 11th Lunar and Planet. Sci. Conf., vol. 1, 823-837, 1980.
- Zisk, S.H. and P.J. Mouginis-Mark, Oases revisited: Further analysis of the Solis Lacus radar anomaly on Mars, LPSC XII, 1239-1241, 1981.
- Downs et al., New radar-derived topography for the equatorial belt of Mars, LPSC XIII, 182-183, 1982.
- Roth, L.E. and R.S. Saunders, Microwave reflectivity of the multi-layer models of the Martian surface, LPSC XV, 693-694, 1984.
- Roth et al., Mars: Seasonally variable radar reflectivity, LPSC XVI, 712-713, 1985.
- Roth et al., Radar and the detection of liquid water on Mars, LPI TR 85-03, 71-73, 1985.

Two other publications relevant to the Solis Lacus controversy are:

- Lee, S.W., Seasonal and secular variation of the Solis Lacus albedo feature: Relation to the martian dust-transport cycle, LPSC XVI, 483-484, 1985.
- Zent, A.P., and F.P. Fanale, Solis Lacus brines: Possible chemistry and kinetics, LPSC XVI, 930-931, 1985.

The publications listed in this bibliography describe the initial debate over the existence of a regolith source of atmospheric water vapor in Solis Lacus. New approaches to the analysis of old data, and the acquisition of new data from Earth-based radar and the Mars Observer spacecraft, may resolve this issue in the near future. If nothing else, the debate over Solis Lacus has motivated a rigorous examination of several important data sets, and helped define the limits of their interpretation.

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It has also provided at least a partial stimulus for the development of spacecraft sensors capable of detecting near surface reservoirs of H<sub>2</sub>O. For these reasons alone, it has been a worthwhile exercise.

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